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FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY 'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	Bhatoolaul 4-
	U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 10/019702

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/05098	June 6, 2000 ✓	July 2, 1999 ✓

TITLE OF INVENTION: Code Division Multiple Access System Having Improved Pilot Channels

APPLICANT(S) FOR DO/EO/US: Bhatoolaul, D., Freiberg, L. ✓

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [X] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [X] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [X] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [ ] Other items or information:

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U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/019702	PCT/EP00/05098	Bhatoolaul 4-

21. ☐ The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ **890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ ---	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	15 - 20 =	_____	x **$18.00**	$	
Independent claims	3 - 3 =	_____	x **$84.00**	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$ ---	
SUBTOTAL =				$	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$ ---	
TOTAL NATIONAL FEE =				$ **40.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 930.00	
				Amount to be refunded:	$
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a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 12-2325 in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Docket Administrator
Lucent Technologies Inc.
Room 3J-219
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Holmdel, NJ 07733-3030

SIGNATURE

Jimmy Goo
NAME

36,528
REGISTRATION NUMBER

IN THE UNITED STATES

PATENT AND TRADEMARK OFFICE

Patent Application

Inventors David Lahiri Bhatoolaul
Lorenz Fred Freiberg

Case 4-16

Serial No.

Examiner

Title Code Division Multiple Access System Having Improved Pilot Channels

ASSISTANT COMMISSION OF PATENTS

WASHINGTON, D.C. 20231

SIR:

PRELIMINARY AMENDMENT

IN THE CLAIMS

Amend claims 3, 4, 5 and 9 and add claims 12 through 15 as follows:

1. In a code division multiple access mobile radio channel communications network, a method of providing pilot symbols comprises providing a first set of pilot symbols through a plurality of pilot channels, each such channel being dedicated to one mobile user; simultaneously providing a second set of pilot symbols through at least one common control channel; and in a mobile combining the first and second sets of pilot

symbols and from said combination estimating the channel impulse response.

2. A method according to claim 1 in which the common channel is one of a broadcast channel or a forward access channel or a paging channel.

3. (once amended) A method according to claim 2 in which the pilot symbols from all common channels are combined.

4. (once amended) A method according to claim 1 further comprising combining static data transmitted on at least one of the common channels with the first and second sets of pilot symbols.

5. (once amended) A method according to claim 1 comprising transmitting from a mobile to a network base station information relating to quality of received pilot symbols, the base station then varying the energy associated with the first set of pilot symbols supplied to that mobile.

6. A method according to claim 5 further comprising the step of varying the time offsets between the radio frames in the dedicated pilot channel and the at least one common channel.

7. A code division multiple access mobile radio telecommunications network comprising a plurality of mobiles each having a dedicated pilot channel; a plurality of base stations; first pilot symbol generation means arranged to supply pilot symbols to the dedicated pilot channels; second pilot symbol generation means arranged to supply to at least one common control channel dedicated pilot symbols embedded between data symbols broadcast by the common control channel; and in each mobile, receiving means arranged to receive pilot symbols in the dedicated pilot channel and the common control channel, combining means to combine the received pilot symbols, channel estimation means to receive the combined pilot symbols, and coherent detection means arranged to vary at least one property of the mobile in accordance with the output of the channel estimation means.

8. A network according to claim 7 in which each mobile is arranged to send to an associated base station information relating to the quality of pilot symbols received on its dedicated pilot channel, and each base station is arranged to vary the energy of said pilot symbols accordingly.

9. (once amended) A network according to claim 8 in which each mobile is further arranged to send to an associated base station information relating to the quality of pilot symbols received on the at least one common channel, and each base station is arranged to vary the time-offsets between radio frames of the dedicated traffic channel accordingly.

10. A mobile for use in a code division multiple access radio telecommunications network comprising first receiving means to receive pilot symbols on a dedicated pilot channel; second receiving means to receive pilot symbols on at least one common channel; combining means to combine said pilot symbols; and channel estimation means connected to the combining means to provide an output to coherent detection means.

11. A mobile according to claim 10 further comprising a set of rake fingers arranged to receive the combined pilot symbols.

12. (newly added) A method according to claim 1 in which the pilot symbols from all common channels are combined.

13. (newly added) A method according to claim 2 further comprising combining static data transmitted on at least one of the common channels with the first and second sets of pilot symbols.

14. (newly added) A method according to claim 2 comprising transmitting from a mobile to a network base station information relating to quality of received pilot symbols, the base station then varying the energy associated with the first set of pilot symbols supplied to that mobile.

15. (newly added) A method according to claim 14 further comprising the step of varying the time offsets between the radio frames in the dedicated pilot channel and the at least one common channel.

REMARKS

Reconsideration of this application as amended is now requested. Claims 3, 4, 5 and 9 were amended and claims 12 through 15 were newly added. Support for newly added claims 12 through 15 can be found in original claims 3 through 6.

No additional fee is due.

On the basis of the above amendments and remarks, reconsideration and allowance of the claims in the application are respectfully solicited.

Respectfully,

David Lahiri Bhatoolaul
Lorenz Fred Freiberg

By ______________________
Jimmy Goo
Reg. No. 36,528

Date: 12/20/2001

MARKED-UP VERSION OF THE CLAIMS

1. In a code division multiple access mobile radio channel communications network, a method of providing pilot symbols comprises providing a first set of pilot symbols through a plurality of pilot channels, each such channel being dedicated to one mobile user; simultaneously providing a second set of pilot symbols through at least one common control channel; and in a mobile combining the first and second sets of pilot symbols and from said combination estimating the channel impulse response.

2. A method according to claim 1 in which the common channel is one of a broadcast channel or a forward access channel or a paging channel.

3. (once amended) A method according to [claim 1 or] claim 2 in which the pilot symbols from all common channels are combined.

4. (once amended) A method according to [any preceding] claim 1 further comprising combining static data transmitted on at least one of the common channels with the first and second sets of pilot symbols.

5. (once amended) A method according to [any preceding] claim 1 comprising transmitting from a mobile to a network base station information relating to quality [(?)] of received pilot symbols, the base station then varying the energy associated with the first set of pilot symbols supplied to that mobile.

6. A method according to claim 5 further comprising the step of varying the time offsets between the radio frames in the dedicated pilot channel and the at least one common channel.

7. A code division multiple access mobile radio telecommunications network comprising a plurality of mobiles each having a dedicated pilot channel; a plurality of base stations; first pilot symbol generation means arranged to supply pilot symbols to the dedicated pilot channels; second pilot symbol generation means arranged to supply to at least one common control channel dedicated pilot symbols embedded between data symbols broadcast by the common control channel; and in each mobile, receiving means arranged to receive pilot symbols in the dedicated pilot channel and the common control channel, combining means to combine the received pilot symbols,

channel estimation means to receive the combined pilot symbols, and coherent detection means arranged to vary at least one property of the mobile in accordance with the output of the channel estimation means.

8. A network according to claim 7 in which each mobile is arranged to send to an associated base station information relating to the quality of pilot symbols received on its dedicated pilot channel, and each base station is arranged to vary the energy of said pilot symbols accordingly.

9. (once amended) A network according to claim 8 in which each mobile is further arranged to send to an associated base station information relating to the quality [(?)] of pilot symbols received on the at least one common channel, and each base station is arranged to vary the time-offsets between radio frames of the dedicated traffic channel accordingly. [n]

10. A mobile for use in a code division multiple access radio telecommunications network comprising first receiving means to receive pilot symbols on a dedicated pilot channel; second receiving means to receive pilot symbols on at least one common channel; combining means to combine said pilot symbols; and

channel estimation means connected to the combining means to provide an output to coherent detection means.

11. A mobile according to claim 10 further comprising a set of rake fingers arranged to receive the combined pilot symbols.

12. (newly added) A method according to claim 1 in which the pilot symbols from all common channels are combined.

13. (newly added) A method according to claim 2 further comprising combining static data transmitted on at least one of the common channels with the first and second sets of pilot symbols.

14. (newly added) A method according to claim 2 comprising transmitting from a mobile to a network base station information relating to quality of received pilot symbols, the base station then varying the energy associated with the first set of pilot symbols supplied to that mobile.

15. (newly added) A method according to claim 14 further comprising the step of varying the time offsets

between the radio frames in the dedicated pilot channel and the at least one common channel.

CODE DIVISION MULTIPLE ACCESS SYSTEM HAVING IMPROVED PILOT CHANNELS

This invention relates to a code division multiple access (CDMA) system, especially a wide band or direct sequence (DS) CDMA system, and relates particularly to the arrangements for providing pilot channels.

For effective use of direct sequence CDMA systems for digital mobile cellular telephone and personal communication network applications, a detection technique must be used which performs well at low signal to interference ratios. Coherent detection is preferred to non-coherent detection because it has better performance in the slow fading environments which typify personal communication channels. To apply coherent detection, the channel impulse response at a receiver must be known, and this can be achieved by transmitting pilot symbols.

Pilot symbols can be transmitted in two ways; a) a dedicated pilot channel, i.e. one pilot channel for each user, in which pilot symbols are embedded periodically (time- or code-multiplexed) in the same channel as the data symbols, or b) a common pilot channel, i.e. one pilot channel for all

users, in which pilot symbols are continuously sent on a separate channel in parallel with data channels.

An advantage of dedicated pilot channels is that power can be varied, so that a mobile at a boundary of a cell can ramp up the power of its received symbols to overcome channel propagation as well as fast fading; however the system relies on good statistical multiplexing of users to ensure that there is always spare transmitter capacity to meet a sudden demand from a mobile for increased power, which can create instability.

The well known differences between the two arrangements will now be described with reference to figures 1-6.

Figure 1a shows the sector coverage angle alpha (e.g. 30° to 40°) over which a small base station transmits. Figure 1b indicates by the enclosed area the energy E_d required to transmit data, and this is assumed to be constant. Figure 1c indicates by the shaded area the energy E_p required to transmit pilot symbols in either a dedicated pilot channel or a common pilot channel.

Figure 2 illustrates energy requirements in a common pilot channel arrangement, and is effectively a merger of figures 1b and 1c; a single continuous pilot channel is broadcast to all users.

Figure 3 illustrates energy requirements in a dedicated pilot channel arrangement; each of the N users (where N = 5) has a different energy requirement E1 to E5, shown by the shaded and crosshatched areas. The total energy requirement for the pilot channels is $N*E_p$. This arrangement assumes there is no power control facility to vary power transmission.

Figure 4 shows a variation of figure 3 including a power control facility. The power supplied to each pilot channel can be controlled individually, as indicated by the different areas of the shaded and crosshatched bands E6 to E10. At certain times, in theory, the pilot in a channel can even be switched off completely, saving energy, and allowing other data or control information to be transported by that channel. Pilot energy requirement is $\Sigma E_{p,i} \bullet \beta_i$ where β_i is the scaling factor for each user, dependant on power control and time multiplexing. β is between 1 and 0, i.e. it is small when a mobile is close to its base station.

However comparison with figure 1c shows that the total power used is unchanged.

Figure 5 indicates energy requirements where spatially adaptive antennas are used. Data energy is transmitted in much narrower sections $\alpha 1$ to $\alpha 4$ within the sector angle α, i.e. a beam forming technique is used. The narrow sectors $\alpha 1$ to $\alpha 4$ are directed towards active mobiles, and the pilot energy required for each narrow sector is also varied in accordance with need, as indicated by the shaded areas. The total energy requirement is greatly reduced. The pilot energy requirement is $\sum_{i}^{N} \beta_i E_p G_A$ where G_A is the gain of the directed antennas.

Figure 6 shows that, in addition to the directed channels of figure 5, some common channel facility is required across the whole sector angle α, e.g. for mobiles attempting to make a call, and the data power for this is indicated at E_{dc}, between the directed sectors with the associated pilot energy indicated by the cross-hatched areas E_{pc}. Pilot energy requirements are $\sum_{i}^{N} \beta_i E_p G_A + \sum_{i}^{C} \beta_i E_p$, where C is the number of common channels.

It is the object of the invention to provide a pilot channel arrangement having reduced energy requirements.

According to the invention in a code division multiple access mobile radio telecommunications network, a method of providing pilot symbols comprises providing a first set of pilot symbols through a plurality of pilot channels, each such channel being dedicated to one mobile user; providing a second set of pilot symbols through at least one common control channel; and in a mobile combining the first and second sets of pilot symbols and providing said combination to channel impulse response sensing means.

In effect the common pilot energy $\sum_{i}^{C}\beta_i E_p$ is used by a mobile in addition to pilot energy provided on its dedicated pilot channel.

The common control dowmlink channel may be a broadcast channel or a forward access channel or a paging channel.

Also according to the invention a code division multiple access mobile radio telecommunications network comprising a plurality of mobiles each having a dedicated pilot channel; a plurality of base stations; first pilot symbol generation

means arranged to supply pilot symbols to each dedicated pilot channel; second pilot symbol generation means arranged to supply to at least one common control channel dedicated pilot symbols embedded between data symbols broadcast by the common control channel; and in each mobile receiving means arranged to receive pilot symbols in the dedicated pilot channel and the common control channel, combining means to combine the received pilot symbols, channel estimation means to process the combined pilot symbols, and coherent detection means arranged to vary at least one property of the mobile in accordance with the output of the channel estimation means.

The invention will now be described by way of example with reference to Figures 7 to 10 in which:-

Figure 7 is a schematic drawing of a DS CDMA network;

Figure 8 indicates the energy extraction process in a method according to the invention;

Figure 9 shows in more detail one of the mobiles of Figure 7, operating according to the invention; and

Figure 10 shows in more detail one of the base stations of Figure 7, operating according to the invention.

In Figure 7 a wireless telecommunication system 10 comprises a number of mobile stations (MS) 11,12,13,14 and a number of base transceiver stations N node B 15,16,17,18 connected through a radio network controller (RNC) 19,20 (all in the radio access network RAN 21) to a core network (CN) 22. The CN is connected to the public switched telephone network PSTN 23.

In Figure 7, each mobile 12 is provided with a dedicated pilot channel which carries pilot symbols to the mobile; the mobile uses these symbols to determine the extent of some of the key radio channel effects on desired transmitted signal to the mobile.

Examples of these radio channel effects are:

i) Offset in frequency die to the well known mobile radio channel Doppler effect;

ii) Offset in timing sunchronisation die to multipath propagation;

iii) Energy loss in the transmitted signal due to propagation loss and fast-fading induced by multipath propagation.

With a knowledge of the extent of key radio channel phenomena the mobile can configure the various functions/processes/schemes that demodulate the received signal, such as the timing and tracking synchronisation and channel estimation, to minimise the distortion caused by radio channel phenomena. In addition, the mobile can provide feback to the network, suggesting means to vary certain characteristics of its downlink reception and demodulation.

In the system illustrated in Figure 7, as is well known, there are a number of common control channels in the downlink which are commonly broadcast by the network; such channels typically include a broadcast channel BCH, a forward access channel FACH and a paging channel PCH.

The BCH is used to provide cell-specific information, such as the cell identity and the available short and long codes for random access channel RACH transmission; information about neighbouring cells can also be provided. In the majority of cell scenarios the information carried by the BCH

can be assumed to be static for the duration of most telephone calls.

The FACH is primarily used to carry initial call set-up control information to a mobile when the system knows the location cell of the mobile. The FACH can also carry short intermittent packet information.

The PCH is used to carry information primarily to initiate network originated calls, eg from a landline telephone, to a mobile station when the system does not know the location cell of the mobile. The PCH may have a sleep mode when traffic is low.

These and other common control channels are separated from one another by channelisation codes, and possibly also be fixed time-offsets.

In the arrangement there is no common pilot channel, therefore each channel in addition has its own dedicated pilot symbols which are embedded at regular intervals between the transmitted data symbols.

In the present invention a mobile 12 utilises the pilot symbols in existing common downlink channels in addition to the pilot symbols provided by its own dedicated pilot channel or channels. By use of such a combination decreased energy is required in the dedicated pilot channel of the mobile.

Figure 8 shows the energy flows. The pilot channel of the mobile 12 is referred to as a hybridised common pilot channel HCPC 30, and pilot information from it flows through a first rake finger 32 to a channel estimator in two stages 34, 36. Pilot information from at least one of the downlink channels, indicated at 38 as a dedicated traffic channel, passes through a second rake finger 40 to the channel estimators 34, 36. (Although two sets of rake fingers are shown, in practice only one may be needed). The output of the estimators 34, 36 passes to a conjugate multiplication stage 42 which also receives input directly from the dedicated traffic channel, and then to a maximum ratio combining stage 44. The output of the combining stage, connected to the processor of the mobile, indicates channel impulse response of the mobile's receiver, and permits use within the mobile of coherent detection techniques.

The channel estimation functional units 34,36, are shown in two stages to indicate the possibilities of:

i) Combining in stage 34 the de-spread pilot symbol energy from the dedicated traffic channel and Hybridised Common Pilot Channel sources to create effectively a single pilot source which is then used to estimate the extent of channel distortion in stage 36;

ii) Independently calculating channel estimates from the two despread pilot symbol sources in stage 34 and then combining the two resultant sets of channel estimates in stage 36.

The channel estimates produced by the channel estimation functional units 34,36 are used by the conjugate multiplication stage 42 to mitigate the effects of channel distortion on the desired de-spread signal using coherent detection.

The use of information from at least one broadcast channel allows lower pilot energy input through the hybrid channel, i.e. in figure 2, E_p can be reduced.

Usually there will exist an almost continuous stream of pilot symbols from of the available downlink several common

control channels such as the BCH, FACH and PCH. Since all the channels experience the same channel conditions, the mobile can obtain accurate and robust multi-path tracking information, as well as channel estimates.

The energy flow arrangement illustrated in Figure 8 applies when there is a non-zero offset between the two sets of pilots; the parallel receiver structure allows the two sets of pilot symbols to be demodulated in parallel.

If there is no time offset between the two sets of pilot symbols, parallel pilot symbol energy flows such as illustrated in Figure 8 will not be necessary, and a sub-set of existing rake fingers can be allocated to demodulate just the multipath components which are deemed to require extra robust channel estimation ; this requires additional rake finger management.

A typical mobile 12 is shown in Figure 9. It has a RF transceiver 50 connected to a baseband demodulator 52 which passes control data to a control signal process of 54 and data signals to a decoder connected to a user data processor 58.

A further reduction in pilot energy can be achieved by incorporation of base station (BTS) intervention. The mobile 12 is arranged to provide feedback signals to the BTS about the quality of its HCPCH, ie the noise or power or phaseb rotation of the pilot symbols. The BTS can then reduce the power of the pilot symbols in the mobile's dedicated pilot channel in comparison with the power of the data symbols. A further advantage of such a power variation is that, depending on the cell scenario, it will reduce the overall power transmitted by a BTS on the downlink, which for a multi-user CDMA system (Fig.7) improves the downlink capacity.

To provide BTS intervention, additional parts of the mobile 12 are affected; referring to Figure 9, the control data processor provides the required information to the BTS by a loop to the base band demodulator 60 in the mobile, its output being connected to the RF transceiver 50.

A yet further improvement is provided by adapting one of the common channels, using the BTS intervention arrangement described above. The channel and tracking estimation stages, 34, 36 in Figure 8, are arranged to estimate the performance gains from the HCPCH; this performance gain can be improved by adapting the time-offsets between the pilot symbols belonging

to the common channel(s) being used to generate the HCPC and the pilot symbols transmitted on the dedicated traffic channel(s) to suit channel conditions. In most circumstances it will be preferable to have the HCPCH pilot aligned in time with the DTCH to simplify the channel estimation combining process represented by 34,36. However, in some circumstances, e.g. when the channel is varying very quickly, it will be preferable to have the HCPCH pilots occurring half-way between DTCH pilots; this can significantly improve multi-path tracking performance.

Such an arrangement affects a base station BTS; a typical arrangement is shown in Figure 10 in which a mobile 70 is connected to a BTS 72 which is controlled by a RNC 74. The RNC 74 controls the timing of the pilot symbols in the common channels which provide inputs as dedicated traffic channel energy in Figure 8, and can therefore vary the timing of the symbols with respect to the dedicated pilot channel symbols, as required.

Instead of shifting the timing of the pilot symbols in the common channels, in another variation the RNC 74 can be arranged to substitute pilot symbols for data symbols on common channels such as the FACH or PCH to create Extended

HCPC (EHCPC) channels. Doing this trades-off common channel capacity (eg the number of calls that can be set up or acknowledged in a unit of time) for improved channel estimation at a mobile.

Alternatively without the need for RNC intervention, the mobile can use the effectively static data symbols ona common channel such as the BCH as pilot symbols to create EHCPC. A mobile must always listen to such a channel for new calls, or for a paging service message, and such channels are rarely congested.

Claims

1. In a code division multiple access mobile radio channel communications network, a method of providing pilot symbols comprises providing a first set of pilot symbols through a plurality of pilot channels, each such channel being dedicated to one mobile user; simultaneously providing a second set of pilot symbols through at least one common control channel; and in a mobile combining the first and second sets of pilot symbols and from said combination estimating the channel impulse response.

2. A method according to claim 1 in which the common channel is one of a broadcast channel or a forward access channel or a paging channel.

3. A method according to claim 1 or claim 2 in which the pilot symbols from all common channels are combined.

4. A method according to any preceding claim further comprising combining static data transmitted on at least one of the common channels with the first and second sets of pilot symbols.

5. A method according to any preceding claim comprising transmitting from a mobile to a network base station information relating to quality (?) of received pilot

symbols, the base station then varying the energy associated with the first set of pilot symbols supplied to that mobile.

6. A method according to claim 5 further comprising the step of varying the time offsets between the radio frames in the dedicated pilot channel and the at least one common channel.

7. A code division multiple access mobile radio telecommunications network comprising a plurality of mobiles each having a dedicated pilot channel; a plurality of base stations; first pilot symbol generation means arranged to supply pilot symbols to the dedicated pilot channels; second pilot symbol generation means arranged to supply to at least one common control channel dedicated pilot symbols embedded between data symbols broadcast by the common control channel; and in each mobile, receiving means arranged to receive pilot symbols in the dedicated pilot channel and the common control channel, combining means to combine the received pilot symbols, channel estimation means to receive the combined pilot symbols, and coherent detection means arranged to vary at least one property of the mobile in accordance with the output of the channel estimation means.

8. A network according to claim 7 in which each mobile is arranged to send to an associated base station information relating to the quality of pilot symbols received on its dedicated pilot channel, and each base station is arranged to vary the energy of said pilot symbols accordingly.

9. A network according to claim 8 in which each mobile is further arranged to send to an associated base station information relating to the quality (?) of pilot symbols received on the at least one common channel, and each base station is arranged to vary the time-offsets between radio frames of the dedicated traffic channel accordingly. n

10. A mobile for use in a code division multiple access radio telecommunications network comprising first receiving means to receive pilot symbols on a dedicated pilot channel; second receiving means to receive pilot symbols on at least one common channel; combining means to combine said pilot symbols; and channel estimation means connected to the combining means to provide an output to coherent detection means.

11. A mobile according to claim 10 further comprising a set of rake fingers arranged to receive the combined pilot symbols.

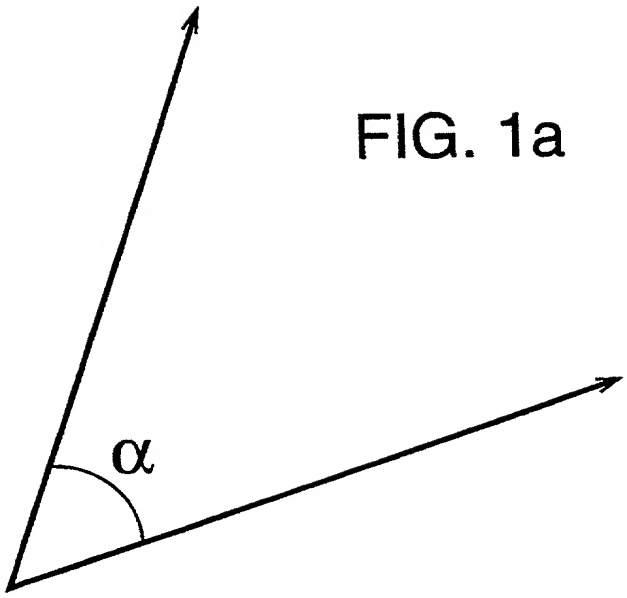


FIG. 1a

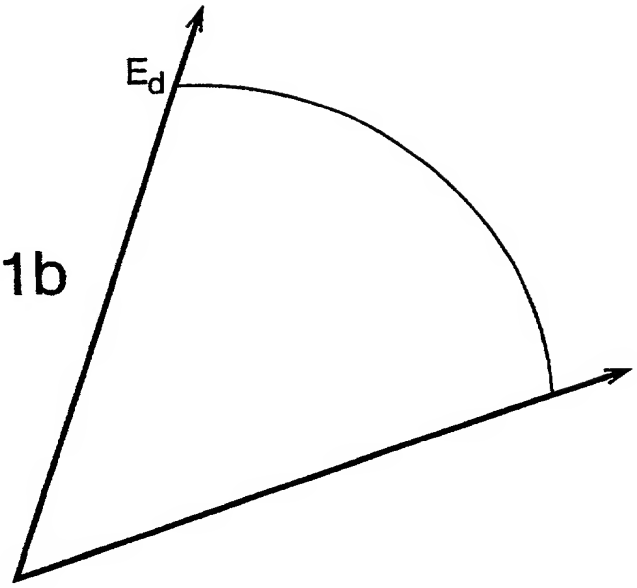


FIG. 1b

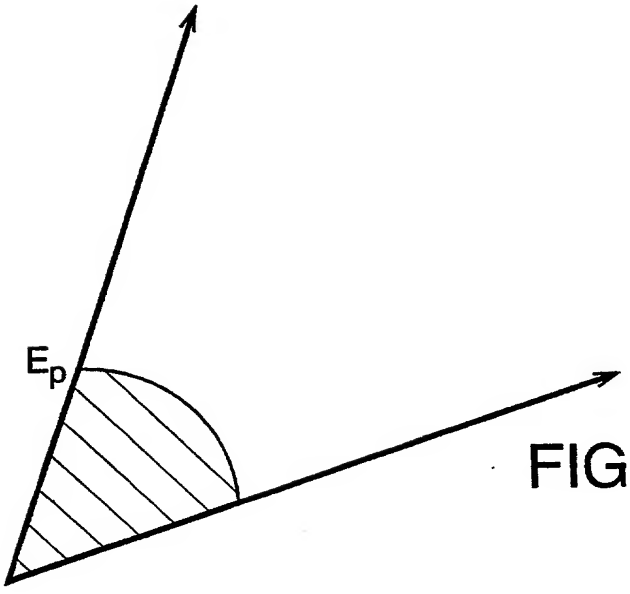


FIG. 1c

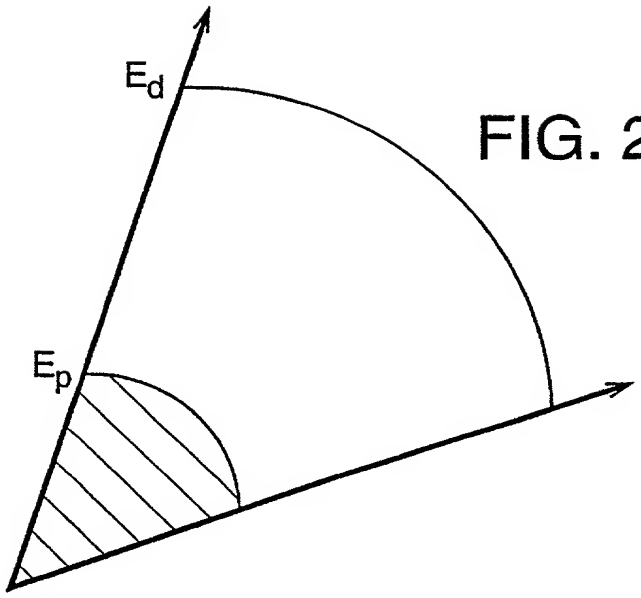


FIG. 2

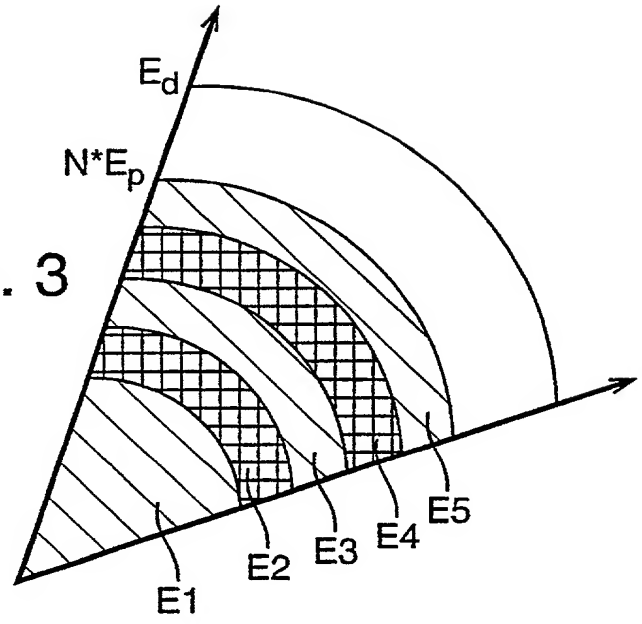


FIG. 3

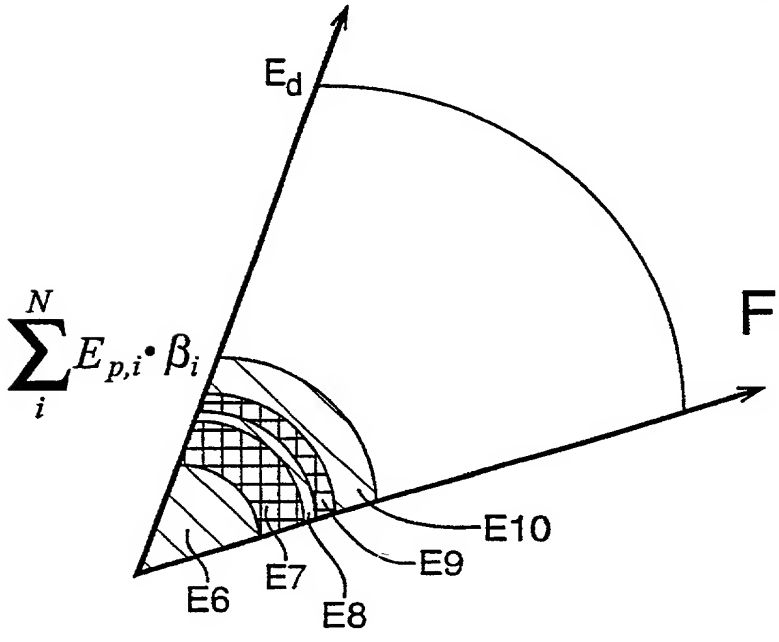


FIG. 4

FIG. 5

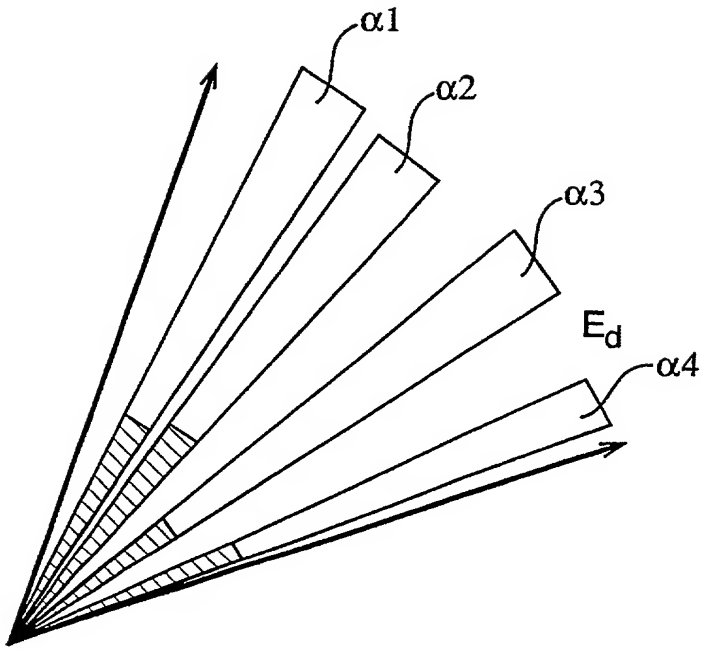


FIG. 6

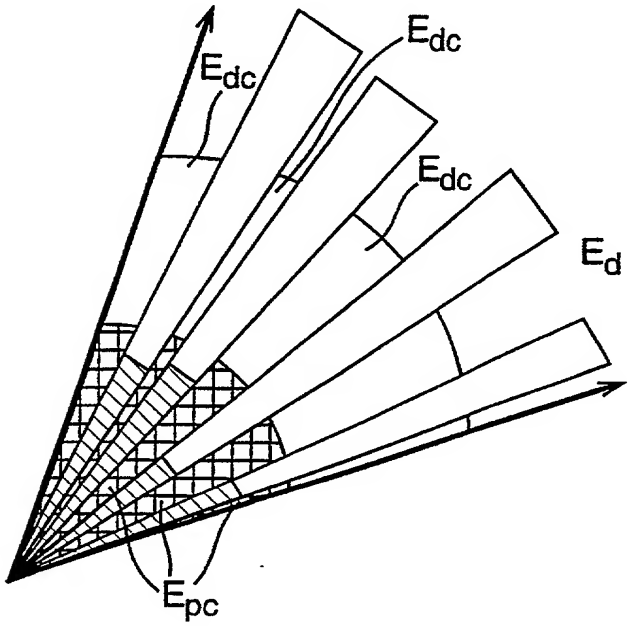
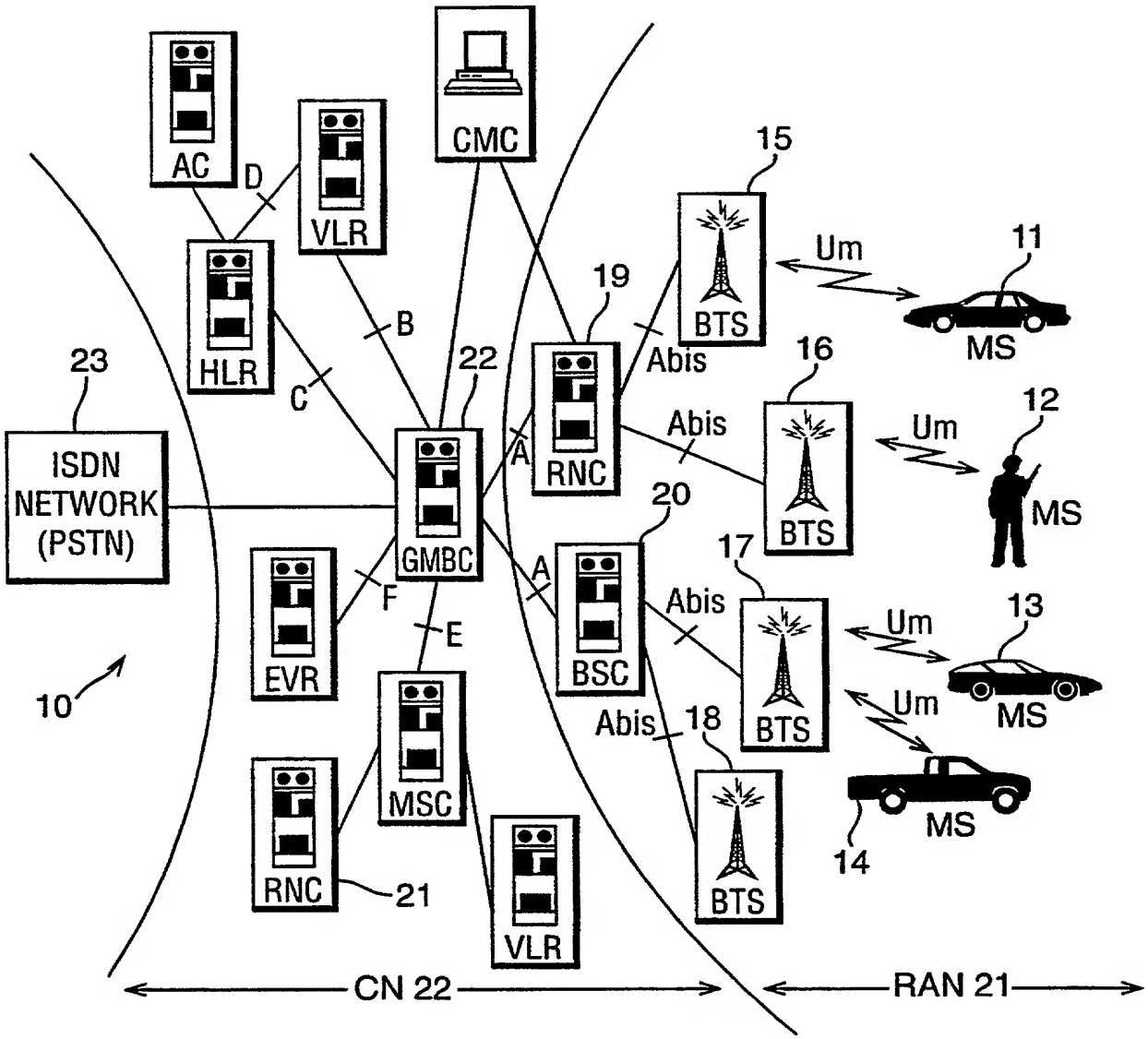


FIG. 7


AC
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HLR
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ISDN
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(PSTN)
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RNC
Abis
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BTS
MS
GMBC
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A
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EVR
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CN 22
RAN 21

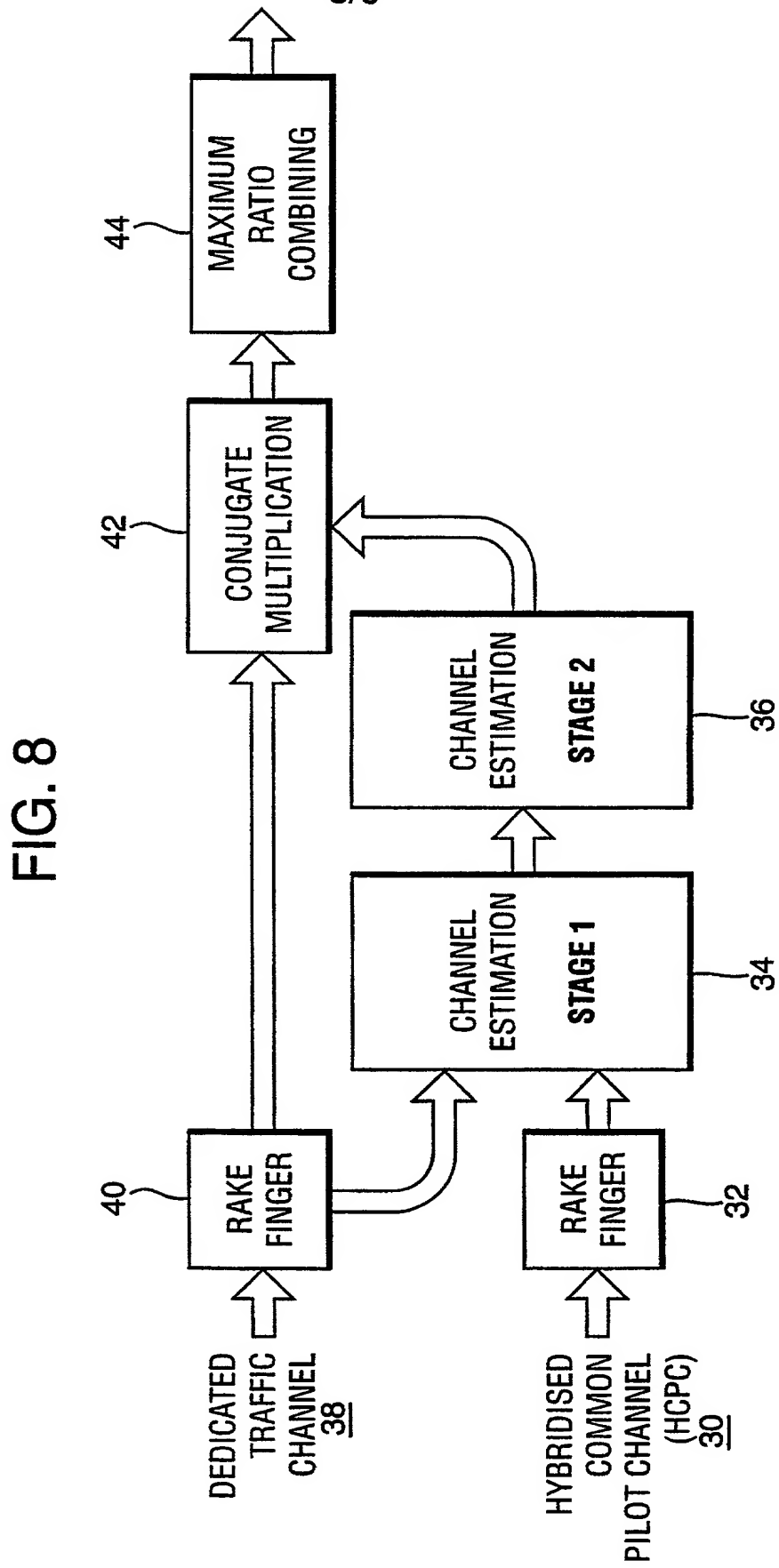
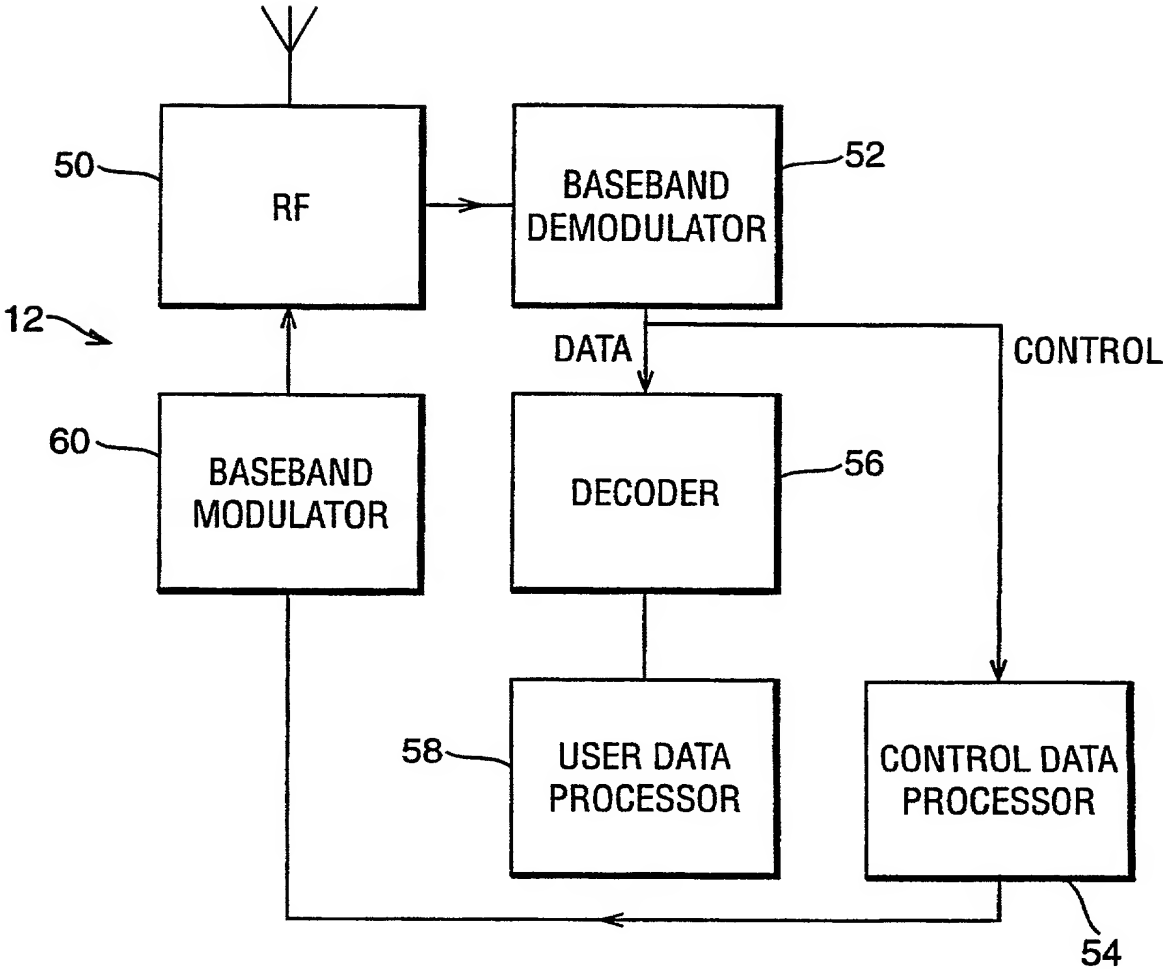


FIG. 8

FIG. 9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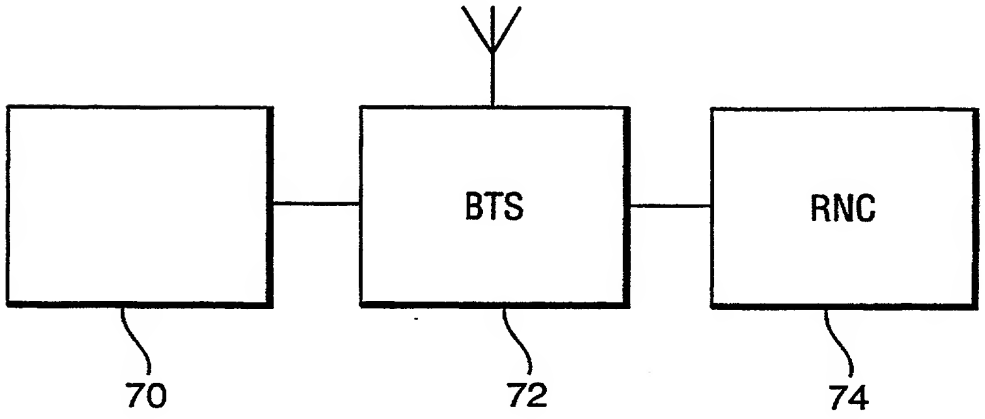
RF
52
BASEBAND DEMODULATOR
12
DATA
CONTROL
60
BASEBAND MODULATOR
DECODER
56
58
USER DATA PROCESSOR
CONTROL DATA PROCESSOR
54

FIG. 10


BTS
RNC
70
72
74

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Declaration and Power of Attorney

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled
System Having Improved Pilot Channels the specification of which

[✓] is attached hereto

OR

[ ] was filed on _____ and granted Application Serial Number _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

European Application No. 99305246.3 Filed: July 2, 1999

I hereby claim the benefit under Title 35, United States Code, 120 of any foreign application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

International Application No.	**Filing Date**	**Status**
PCT/EP00/05098	June 2, 2000	Pending

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States

Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby authorize these attorneys to insert in the above blanks the filing date and application serial no. when known.

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